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hours, and making it obligatory for the teacher to be on hand and to decline other engagements, which might otherwise be given precedence.

Such an arrangement adds zest to the work, in that it creates the atmosphere of mutual understanding and interest so much prized in the graduate school, and clarifies the teacher's own thinking as he explains the details to the students. It may afford, moreover, some little positive assistance, for there may well be parts of the routine experimental work or calculations that students can become skilful enough to perform with entire satisfaction. Several years ago, for example, I had on hand a piece of work in which an important part of the procedure was the repeated performance of very accurate weighings. I trained four students, at various times, in the theory of the balance and the practise of precise weighing, and while I prepared specimens, the students weighed them with as much skill and care as I myself could have done it. By no means the least benefit of this plan is its effect upon the student. No better training in perseverance and accuracy, no greater incentive to advanced study, no clearer insight into the real spirit of research, could be afforded the young learner than by this means. The realization that he is actually contributing to the sum of human knowledge is, to his developing nature, exhiliarating in the extreme. And best of all, no greater opportunity could be offered the teacher for that personal touch and influence which is the sacred privilege of the teacher's profession.

The research worker should make his work known. It is a most helpful thing to crystallize one's ideas from time to time in the form of connected statement, or better still, to keep a continuous written account of his procedure, his difficulties, and his results. To this end, he will find it of advantage to identify himself, by correspondence at least, with some not too distant university seminar, and contribute to its programs at suitable intervals in the form of research reports; to participate actively in the work of scientific organizations such as the Academy of Science, the American Physical Society, etc.; and to prepare his communications in suitable form for printing, at least in abstract. Another helpful feature is found in having a local scientific club, similar to the Baconian Club of this university or the Kelvin Society of Coe College, where people of somewhat kindred interest may get together and exchange experiences and catch something of one another's vision. In these ways the research worker gains the benefit of friendly encouragement and equally friendly criticism, and often has cause to appreciate the maxim that "two heads are better than one."

Above all, let us realize that we are never too old to learn, and that the most dangerous thing a teacher or a scientific man can do is to cease studying. Let the college scientist read books on new phases of his subject as they come out, even if he does not follow every technical detail, and even if he is obliged to borrow them from some university library for the purpose. Let him keep a classified card index of all the periodical literature available on his subject, noting especially articles that may suggest lines of investigation of particular interest to himself. Let him think beyond the daily topics of the classroom, let him mingle with practical men and get the bearing of his science on the affairs of the world. And what is most important, let him keep in touch with others of his calling, through visits and correspondence, so that in every possible way he may be open to the inspiration which comes with the pursuit of truth. For it is in these ways that the man who contributes to the welfare of mankind through scientific research lays his heavy foundations.

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WAXY MAIZE FROM UPPER BURMA

A variety of maize introduced from Shanghai, China, in 1908, was found to have seeds with a new type of endosperm. In the seeds of this variety the texture of the starchy tissue is unlike that of any variety previously known. This new type of endosperm has been called waxy. Although distinct from other types, waxy endosperm is by no means

conspicuous, and since all the previously known types of endosperm are very widespread, essentially coextensive in fact with maize on the American Continent, it seemed not improbable that the existence of waxy endosperm in America had been overlooked.

With the hope of discovering the origin of this type of endosperm the collection of maize varieties in the Office of Crop Acclimatization was gone over with endosperm texture particularly in mind. The geographical distribution of the varieties examined was as follows: North America, north of Mexico, 369 varieties; Mexico, 152; Central America, 105; West Indies, 9; South America, 378; Europe, 60; Asia, 78; Africa, 22; Islands of the Pacific, 3.

The results of this investigation were entirely negative. The variety imported from Shanghai was the only one in which waxy endosperm was found. Not only was waxy endosperm absent from the American continent, but it appeared to be confined to the one locality in Asia.

In 1915 Mr. H. O. Jacobson was commissioned to make a special study of the distribution of the waxy type of maize in China. He found it at Tanyang near Suchou and at Táitsáng, but in both of these localities it was found to have been introduced from Liuho near Shanghai. Mr. Jacobson's observations are summarized in his report as follows:

1. The distribution of the waxy corn is very limited. When found away from Liuho, the original seed can be traced back to that community. Dr. Farnham states he noted the white waxy variety as Liuho fifty years ago.

2. The reason for limited distribution is that but little corn is grown in the immediate vicinity of Liuho, because it is not as profitable as other crops. Secondly, it is a poor yielder when compared with the varieties grown about Nanking, and, thirdly, it perhaps does not make as good "grits" as the corneous sorts.

3. I can not find any legend whatever. Among the farmers it is known by the usual name applied to maize and at Táitsáng, at least, no difference is made between the waxy and non-waxy.

4. At Táitsáng the non-waxy sort is cultivated, as well, and judging by the percentage of non-waxy seed ears saved, the waxy seed ears are very much in the minority.

No additional examples of this new type of endosperm came to light until late in 1915 when a few waxy seeds were found in a sample of maize collected for the Office of Foreign Seed and Plant Introduction by Mr. F. Kingston Ward in Upper Burma.

Breeding experiments showed the endosperm character from the two localities to be genetically identical. Independent origin seemed very unlikely nor was it probable that seed could have been imported from Shanghai into this remote region of Upper Burma. It was therefore assumed that although the sample contained but few waxy seeds, there must be somewhere in the Burma region, at least one locality where waxy maize was the prevailing type.

This expectation has been fully realized, the demonstration coming in the form of a collection of maize varieties recently received by the Office of Seed and Plant Introduction from Mr. E. Thompstone, Deputy Director of Agriculture, Northern Circle, Burma.

The collection consisted of 46 samples from the Northern and Southern Shan States and the Pokokku Hill Tract, most of the varieties with distinctive native names. Of the 46 samples twelve were found to have a horny endosperm, 19 a waxy endosperm and 8 were mixed. The remaining samples had been completely destroyed by insects.

One of the lots from the Southern Shan States consisted of eleven ears all of a uniform dark blue color and all waxy. Another sample consisted of 8 ears which were uniformly white, blue or pink, all of them having a waxy endosperm.

The discovery of this unique character of a plant of American origin in two isolated localities of Asia makes it of interest to learn something of the agricultural practises of the people growing this type of maize.

An excellent account of the various tribes of Upper Burma is given by Scott.[1]

From this and other official accounts it

[1] Scott, J. G., "Gazetteer of Upper Burma and the Shan States," 5 vols. Rangoon, 1901.

appears that the growing of maize is largely confined to the less civilized tribes living in the more mountainous and inaccessible parts of the country. Thus

> The Tingpan Yoo are an agricultural people, but they cultivate only in the hills and not generally at a lower altitude than from 4,000 feet above sea-level. They grow paddy, cotton, maize and poppy.[2]

Another primitive tribe, the Wa, grow maize and buckwheat as their only crop plants. So isolated is this tribe that Mr. Scott, writing in 1846, makes the statement that

> One British party has passed through the heart of the wild Wa country and they are perhaps the only strangers who have ever done so.

This isolation is due to the natural inaccessibility of the country which is six or seven thousand feet above sea level and exceedingly broken in character and to the dangers to which travelers are exposed from the natives. The Wa are still such ardent head hunters that few outsiders care to enter their country. Yet head-hunting with the Wa seems to be an agricultural rather than war-like practise. It is furthermore subject to certain restrictions as the following quotation shows:

> Though heads are taken in an eclectic, dilettante way whenever chance offers, there is a proper authorized season for the accumulation of them. Legitimate head-cutting opens in March and lasts through April. The old skulls will ensure peace for the village, but at least one new one is wanted, if there is not to be risk of failure of the crops, the opium, the maize and the rice.[3]

In the Sagaing district, which is just south of Mandalay, maize is grown with lima beans, the maize plants serving as supports for the beans. This in one of the regions where the crop is grown for the husks rather than the grain.

> When young the cobs are enveloped in large, soft, leaf-like sheaths. These sheaths, when dried, are known to Burmans as *pet* and are used as wrappers for Burmese cheroots. The production of *pet* is the most important use of the plant. The cobs or female inflorescences are rarely allowed to mature, unless when wanted for seed, but are boiled and eaten as a vegetable.[4]

In *Scott's Gazetteer* the husks, as cheroot wrappers, are repeatedly mentioned as the most important use of maize. It also appears that the native varieties are especially adapted to this purpose, thus it is stated that in Pakokku

> American maize was grown for a time experimentally, but the husks proved too coarse for cheroot covers.[5]

We may therefore assume that the "Whackin white cheroot" of Kipling's Supi yaw lat was wrapped in the husks of waxy maize.

During the past season waxy endosperm has been discovered in still another part of Asia by Dr. W. H. Weston. Four ears grown at Los Baños in the Philippine Islands from seed originally from the Island of Mindanao were sent to the Department of Agriculture by Dr. Weston. All these ears contain a small percentage of waxy seeds.

At present there is no way of deciding whether this occurrence of waxy endosperm in the Philippines is the result of a recent introduction from Shanghai or whether it represents another of the early stations comparable with Burma and Shanghai.

Waxy endosperm has been used extensively in genetic experiments and has been crossed with all other known types of endosperm. It continues to behave as a single Mendelian unit inherited in a strictly alternative manner. It is in fact the only character of maize studied at all exhaustively, for which no modifying factors have been found.

The strictly alternative inheritance of waxy endosperm would suggest that it had originated through a single mutation. Parallel mutations are not uncommon but it is difficult to believe that the same mutation should have occurred independently in two localities

[2] *L. c.*, vol. I., Pt. I., p. 602.

[3] Scott, J. G., "The Wild Wa," *The Imperial Asiatic Quarterly Review*, 1896, p. 143.

[4] McKerral, A., Agricultural Surveys No. 2, Dept. of Agri., Burma, p. 10. 1911.

[5] *L. c.*, Pt. II., Vol. II., p. 723.

in Asia where maize is but little grown and should not have come to light on the American Continent where maize is cultivated so extensively and the varieties are so much better known.

If it is admitted that the waxy character is the result of a single mutation then all discussion of the time when it arose is of course idle, for a single mutation may have occurred as well at one time as another. There still remains the peculiar distribution of waxy endosperm and the differentation of other characters as evidence of the antiquity of the waxy mutation. The Shanghai variety in which waxy endosperm was first discovered possessed other peculiarities, the most conspicuous of these being erect leaf blades, monostichous arrangement of the upper leaf blades and an early development of silks while the ear is still enclosed in the leaf sheath. Unlike waxy endosperm, these characters are not definitely alternative in inheritence, but appear in varying degrees in crosses with varieties not showing these characteristics.

Although the expression of all these plant characters is variable even in the uncrossed waxy strain, pure stocks of this variety always present a distinctive appearance that immediately separates them from any other variety. It has been demonstrated that none of these plant characters is correlated with endosperm texture nor are any of them correlated with one another. It is, therefore, not surprising that the plants grown from the waxy seeds from Upper Burma did not resemble the Shanghai variety in any other particular. If the view that the waxy maize of Shanghai came originally from the region of the eastern Himalayas be accepted, we must conclude that sufficient time has elapsed since the introduction for the Shanghai variety to acquire its distinctive characters.

In the light of our present knowledge this unique character of an American plant appears to be confined to three isolated localities in Asia. Unfortunately, nothing is known regarding the maize varieties of Yunnan or other points along the route from Burma to Shanghai. If the waxy character originated in only one of these localities, however, it would seem much more reasonable to assume Burma as the region from which Shanghai received the character than vice versa. This is indicated by the inaccessibility of the region occupied by the Hill Tribes of Burma, the specialized uses of the plant, and the extensive series of named varieties.

The finding of this peculiar type of endosperm in the mountain region of Upper Burma supports the idea that maize entered China from the west instead of the east. This is in accord with the early Chinese accounts of maize as presented by Dr. Laufer. A more thorough knowledge of the maize varieties of the Himalayan regions promises to be the key to the distribution of maize in Asia.

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PHYSICAL MEASUREMENTS IN PSYCHOLOGY

THE recent article by Dr. Paul E. Klopsteg[1] on physical methods and measurements and the obligation of physics to other sciences, carries a strong appeal for those psychologists who are obliged to prepare students for research in the investigations of human behavior. The specialization found in the psychological laboratories is often merely due to the development of a special technique in physical measurements suited to a whole series of problems, rather than to a restricted psychological interest. Recent progress in psychological methods demonstrates very clearly that every problem dealing with the fundamental aspects of human behavior is also partly a physical problem. Much of the apparatus used in making measurements is "home-made" and while good results have been secured, it is equally true that better experimental results would be secured and much time saved if some expert in physical measurements, who is also interested in the

[1] SCIENCE, April 16, 1920, N. S., 51, 384–386.